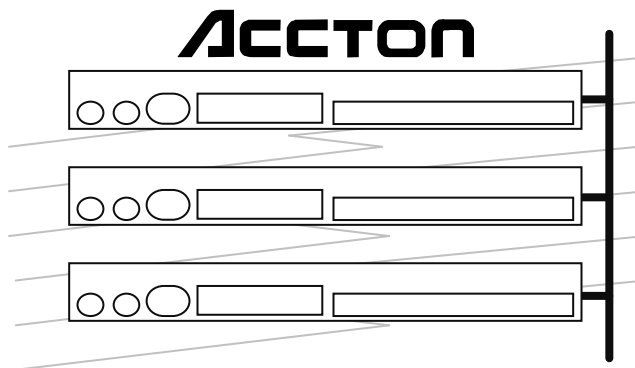


SwitchHub-2s

Installation Manual



Installation Manual

SwitchHub-2s

*2-Port Ethernet Switching Hub
for 10BASE-T/100BASE-TX*

Accton

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About this Guide

This guide is designed for the experienced network installer. It describes how to install and operate Accton's Fast SwitchHub-2s Ethernet switch. After reading this manual, you should be able to use the front display panel and configure options to manage all your network connections.

This manual covers the following topics:

- Product description, summary of important features and specifications
- Brief description of the SwitchHub-2s
- Description of significant components of the unit including LED indicators, ports and buttons
- System setup and configuration

Package Contents

Carefully unpack the contents of the package and verify them against the checklist given below.

Package Checklist

- ☒ SwitchHub-2s (Model No. EH3001-TX)
- ☒ AC power cord
- ☒ Installation manual
- ☒ Owner registration card

Please inform your dealer immediately should there be any wrong, missing, or damaged parts.

If possible, retain the carton, including the original packing materials. Use them again to repack the unit in case there is a need to return it for repair.

To qualify for product updates and product warranty registration, fill in the **Owner Registration Card** and return it to Accton Technology Corporation.

Quick Installation

The SwitchHub-2s contains 2 Ethernet ports, each of which supports 100BASE-TX or 10BASE-T connections, operating at full or half-duplex. The smart design built into the front display panel and configure options, provides a friendly interface that simplifies installation and network troubleshooting. If you are already familiar with basic network operations, you should be able to install this switch as described below:

1. Unpack the SwitchHub-2s.
2. Find a location close to the network devices you need to connect, and within easy reach of an electrical outlet.
3. Connect workstations or servers to the MDI-X station ports.
4. Connect to other hubs via the MDI port.
5. Set the transmission mode for each port to full or half-duplex.
6. Verify network communications by ensuring that -
 - you have made all the necessary connections
 - you can access any connected resources
 - the hub's indicator LEDs are functioning properly

Note: For devices connected directly to either port on the switch, it will automatically detect transmission speed (10/100 Mbps). However, unless the connected devices are operating at half-duplex (i.e., system default), you will have to manually set the transmission mode via the configure button. (Refer to Full/Half Duplex Mode Selection in Chapter 2).

If you encounter any problems in installing the SwitchHub-2s, refer to Chapter 3 for a detailed description of installation procedures, or to Appendix A for help in troubleshooting.

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Chapter 1: Introduction

Switching Technology

The Ethernet Switch allows simultaneous transmission of multiple packets via an internal high-speed data channel. This means that it can partition a network more efficiently than bridges or routers in most environments. The Ethernet Switch is therefore fast being recognized as one of the most important building blocks for today's networking technology.

The learning function in the switching hub stores the address and corresponding port number of each incoming and outgoing packet in a routing table. This information is subsequently used to filter packets whose destination address is on the same segment as the source address. This confines network traffic to its respective domain, reducing the overall load on the network.

The switch scans the destination address from the packet header, searches the routing table provided for the incoming port and forwards the packet only if required, often before fully received. This fast forwarding makes the switch attractive for connecting servers directly to the network, thereby increasing throughput and availability. However, the switch is most commonly used to segment existing hubs, which nearly always improves overall performance. A switching hub can be easily configured in any Ethernet network to significantly boost bandwidth using conventional cabling and adapters.

Accton's Smart Extender (The Fast SwitchHub-2s)

Accton's Smart Extender can boost network bandwidth fourfold, depending on your configuration (i.e., if running at 100Mbps and full-duplex operation for both ports). It provides two 10/100 Mbps RJ-45 ports (set at full or half-duplex) to connect to either a subnetwork, or directly to a server or key workstation. In addition to partitioning an overloaded network, it provides connection between legacy 10BASE-T networks and the newer generation 100BASE-TX, and can be configured to operate in either full-duplex or half-duplex data transfer mode to support the interconnection requirements of other high-speed devices.

This switching hub performs "on-the-fly" cut-through switching, which sends a packet to the other port according to the destination address scanned from the packet header. This technique reduces the latency of packet transmission to 20 microseconds or less. Compared to approximately 800 microseconds for a bridge or 1800 microseconds for a router, both of which have to store the entire packet before the it can be forwarded, the SwitchHub can deliver a quantum improvement in your network's performance.

As a device functioning on the media access control (MAC) layer, the SwitchHub is protocol independent, and therefore compatible with IEEE802.3, IEEE802.3u, TCP/IP, NetWare, DECnet and XNS protocols. Accton's Smart Extender can be configured as a 2-port bridge for a 10BASE-T environment; it can provide a connection between conventional 10BASE-T and high-speed 100BASE-TX networks; or can serve as a 2-port bridge in a 100BASE-TX environment. Moreover, where traditional 100BASE-TX networks restrict the maximum distance between end-nodes to 205 meters, the Smart Extender breaks down this barrier. By breaking your network into smaller and more manageable segments, each linked to the larger network with a switch, the maximum distance for communications between end-nodes is unlimited.

Traditional bridges and routers use a switching method called **store-and-forward** in which the entire frame must be received before the bridge can perform a table look-up for the destination node and forward the packet to the corresponding port. As a result, each packet is delayed by approximately 800 microseconds. It may be necessary to use store-and-forward when a lot data errors are occurring over the network, or when connecting to very slow devices. Compared to this “safe” mode of operation, **cut-through** reduces the packet transmission delay to around 20 microseconds by picking the destination address out of the header as soon as its received, and directing the frame to the appropriate port long before the full packet has been received. The remaining technique, employed to improve data reliability, is called **fragment-free cut-through**. It uses a more conservative approach to cut-through that waits until the collision window has elapsed (i.e., the first full 64 bytes has been received) before processing the packet. This prevents runts from being passed along, effectively cleaning up the data stream.

Although cut-through switching is recommended as the fastest method for most applications, the other methods mentioned above are also supported by the SwitchHub-2s to guarantee flawless performance. To ensure that you can manage any kind of network load, the Smart Extender uses **adaptive cut-through** switching based on Accton's smart algorithm. This method dynamically changes the way it handles data passing through the switch based on the current error rate. These switching alternatives start at standard cut-through for a clean data environment, change to fragment-free cut-through for a moderate error rate, and then progress to store-and-forward for a highly contentious environment. By using this method, the SwitchHub-2s delivers the best networking performance under any environment.

Features of the Fast SwitchHub-2s

- Conforms to the IEEE 802.3 and IEEE 802.3u specifications, as well as 10BASE-T and 100BASE-TX standards
- Provides two independent RJ-45 10BASE-T / 100BASE-TX Ethernet station ports, where each logical port consists of 1 MDI port (for connection to hubs or switches) and 1 MDI-X port (for connection to workstations or servers), eliminating the need for crossover cables
- Both ports support full-duplex and half-duplex operation
- Total bandwidth of up to 200 Mbps (when full-duplex mode is used)
- Auto-senses transmission speed (10/100 Mbps)
- Uses adaptive cut-through switching (which dynamically changes among standard cut-through, fragment free cut-through, and store-and-forward depending on the error rate)
- Uses back pressure to eliminate frame loss by "blocking" traffic from end stations or segments connected directly to the switch when its buffers fill
- Minimum latency of packet transmission (leading edge to leading edge) less than 20 microseconds when using cut-through switching
- Uses "on the fly" cut-through technique to transport packets
- Transparent bridging function supported
- Address learning function to build the routing information database
- Operates at maximum packet filtering and forwarding rate

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- Provides frame filtering and forwarding functions for each port, which are capable of filtering and forwarding 100% of all Ethernet packets at line speed
- Provides a 160K byte buffer per port
- Routing table contains 4K entries per port to store node MAC addresses
- Uses fast hashing scheme to retrieve information from routing table when making routing decisions
- An indicator panel for configuring the system or monitoring the overall condition of the switch, including utilization, forwarding and collision rates

Chapter 2: Hardware Description

Accton's SwitchHub-2s is a highly reliable network switch that complies with IEEE 802.3 (10BASE-T) and IEEE 802.3u (100BASE-TX) specifications. This switching hub delivers superior performance compared to the bridge and router solution, and at a much lower cost. By confining local traffic to the originating segment, and only forwarding cross-segment traffic to the other port, this hub meets the requirements for Ethernet and IEEE 802.3 networks.

This chapter describes the hardware features of Accton's SwitchHub-2s. For easier management and control of the hub, familiarize yourself with the display indicators, ports and configure button. Front and rear panel illustrations in this chapter display the unit's LED indicators, configure button and ports. Before connecting any network device to the hub, read this chapter carefully.

Front Panel

The unit's front panel provides a simple interface for configuring or monitoring the switching hub. It includes a configure button, power indicator, display mode indicators, port status indicators, and a statistical display for network traffic as shown below.

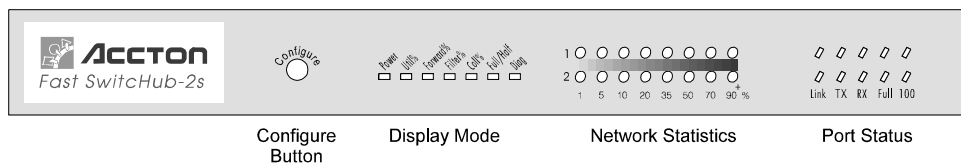


Figure 2.1 The SwitchHub-2s Front Panel

Configure Button

The Configure button is located on the left front panel. This button is used to select the following configuration functions:

- System Performance (displays relative bandwidth utilization rate, forwarding ratio, filtering ratio, and collision ratio for each port)
- Full/Half Duplex (sets port communication mode to full-duplex or half-duplex operations)
- Diagnostics (tests the status of various system components)

To set system performance or diagnostic mode –

1. **To start configuration** use a "long press" on the Configure button. The indicators will light up to show the selected configuration function. (Refer to the related sections in this chapter and in Chapter 3 for complete details.)
2. **To scan through the configuration functions** use a "short press" on the Configure button. (For information on how to select Full/Half duplex communications, refer to Chapter 3.)
3. **To accept and implement the current settings** use a "long press" on the Configure button.



"Long press" means pressing the Configure button for more than 2 seconds and then releasing it. While "Short press" means pressing the Configure button and immediately releasing it. Also, note that if this button is not pressed within 10 seconds, the system returns to normal operation.

SmartWatch™ LED Panel

The comprehensive LED array on the front panel (1) shows if the unit is receiving power, (2) indicates the current display mode, (3) displays network performance for each port, (4) indicates the status of port connections, and (5) shows the result of diagnostic tests. The following figure shows the LED indicators, each of which are described in the following sections.

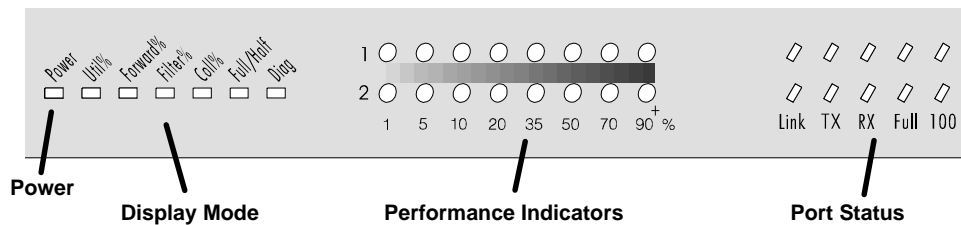


Figure 2.2 SmartWatch LED Panel

Power

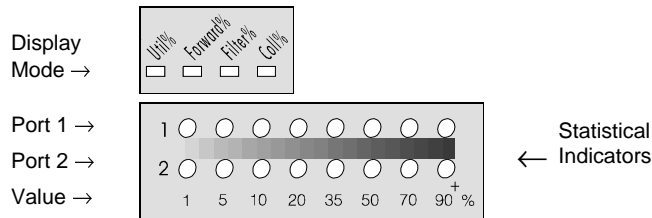
Color: Green

Label: Power

Function: Power indicator

| LED Activity | Condition | Indication |
|--------------|-----------|---|
| STEADY LIGHT | ON | Unit is receiving power, CPU is running. |
| NO LIGHT | OFF | Power is disconnected, no power received. |

Statistical Display for System Performance (Utilization, Forward, Filter & Collision Display Mode)



Color: Green and Orange

Active LEDs: LED rows labeled 1 and 2

Function: Indicates a functional value for each port depending on the selected display mode. (Refer to the Configure Button section earlier in this chapter for instructions on how to select the display mode.)

| Label (%) | Color | Indication |
|-----------|--------|--|
| 90+ | Orange | <i>Util% Display Mode</i> - The utilization percentage of LAN bandwidth. |
| 70 | Orange | |
| 50 | Orange | <i>Forward% Display Mode</i> - The percentage of packets that are forwarded to another port. |
| 35 | Green | |
| 20 | Green | <i>Filter% Display Mode</i> - The percentage of packets filtered because destination is in the current segment. |
| 10 | Green | |
| 5 | Green | <i>Coll% Display Mode</i> - The percentage of collisions occurring out of the total packets transmitted by the port. |
| 1 | Green | |

Utilization Display Mode - (Util%) The statistical indicators show the percentage of valid data passing through each port compared to overall network bandwidth (updated every 0.5 seconds). There are 8 LEDs representing the percentage of network utilization. The corresponding LEDs light up to show that the utilization of LAN bandwidth has reached this percentage. When active, these LEDs behave like a stereo's equalizer display.

For example, if network utilization reaches 1%, the LED labeled 1% will light up. However, if network utilization rises above 1% (e.g., 35%), the LED labeled 35 and all the other LEDs before it (i.e., 1, 5, 10 and 20) will also light up in rapid succession. These indicators monitor the share of valid network frames handled by each port within a 10Mbps or 100Mbps bandwidth, depending on the Ethernet type currently selected on the back panel. They provide a quick way to monitor the current traffic load relative to the network's capacity.

Forward Display Mode (Forward%) - The statistical indicators show the percentage of packets that must be forwarded by bridging hardware to the other port on the switching hub (i.e., another LAN segment or connected workstation). When viewing the Forward% indications, remember that under normal conditions, the SwitchHub forwards 100% of all Ethernet packets that must be transferred among the connected LAN segments at line speed.

Filter Display Mode (Filter%)- The statistical indicators show the percentage of packets that must be filtered from the switching hub by bridging hardware because the destination address is on the same segment connected to the receiving port. When viewing the Filter% indications, remember that under normal conditions, the SwitchHub filters 100% of all Ethernet packets that belong to the local LAN segments at line speed.

Collision Display Mode (Coll%)- The statistical indicators show the percentage of packet collisions occurring out of the total packets transmitted by the port. Collisions occur when two or more devices connected to a hub attempt to transmit data simultaneously on the network. When a collision occurs, devices pause and then re-transmit after a pseudo-random wait period. Because wait periods differ among devices, successive collisions become increasingly improbable.

The Collision LEDs assist the network manager in monitoring the percentage of packet collisions occurring relative to the total packets transmitted by each port. The collision indicators are labeled by row to indicate the percentage of collisions encountered by the corresponding port. When collisions reach a

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level marked on the front panel display, the corresponding LED lights up. For example, if packet collision reaches 1%, the LED labeled 1% will light up. However, if collisions go beyond 1% (e.g., 30%), the LED labeled 30⁺% and all the other LEDs before it (i.e., 1, 5, 10 and 20) also light up in rapid succession.

Setting the Communication Mode (Full/Half Duplex)

Color: Green

Active LEDs: Full/Half (Display Mode LED)

Full (Port Status LED)

Function: The communication mode can be set to either full-duplex or half-duplex operation. Use the Configure button to light the Full/Half Display Mode LED, indicating that the transmission mode may now be set for the ports. Next set the Port Status LED for the corresponding port in the LED column labeled Full as indicated below.

| Full/Half (Display Mode LED) | Condition | Indication |
|------------------------------|-----------|---------------------------------------|
| STEADY LIGHT | ON | Transmission mode selection enabled. |
| NO LIGHT | OFF | Transmission mode selection disabled. |

| Full (Port Status LED) | Condition | Indication |
|------------------------|-----------|--|
| STEADY LIGHT | ON | Port is set for full-duplex operation. |
| NO LIGHT | OFF | Port is set for half-duplex operation. |

- Notes:**
1. Full-duplex mode is supported for both ports.
 2. Full-duplex operation only applies to point-to-point access (e.g., when attaching the SwitchHub to a workstation, server, or another switch). Repeater hubs use a common collision domain for all communications, and therefore cannot support full-duplex mode. When connecting the SwitchHub to a repeater hub, use a standard cascaded connection set for half-duplex communications.

Diagnostics Display Mode

Color: Green
Active LED: Diag
Function: Indicates that the system is in Diagnostic mode. (Refer to the Configure Button section earlier in this chapter for instructions on how to select the display mode.)

After power on, the hub automatically performs a self-diagnostic test. This test is done in two stages. The first stage is the System Diagnostic Test, and the second stage is the Port Diagnostic Test. If a problem is detected, the current diagnostic process (i.e., system or port test) will continue until completed. If the test is not completed successfully, the corresponding LEDs (described below) will flash after test completion to indicate which component failed the test.

System Diagnostic Test

The following table describes the system level failures and corresponding indicators. If a problem is detected, the Statistical Indicators in the eighth column (90°) in both rows will flash to indicate that the device failed the test. The following indicator will also flash to indicate the failure condition.

| LED Indicator (Row, Column) | Color | Component Tested |
|--------------------------------|-------|------------------|
| 1,1 (1%) | Green | System ROM |
| 1,2 (5%) | Green | System EEPROM |











Port Diagnostic Test

The Port Diagnostic Test checks all ports. If a problem is detected, an LED in the corresponding *row* (which indicates the malfunctioning port) and *column* (which indicates the failed component) will light up as shown below.

| LED Indicator (Column) | Color | Diagnostic Test Status |
|------------------------|--------|------------------------------|
| 4 (20%) | Green | Failed Port IC Test |
| 5 (35%) | Green | Failed Routing Table Test |
| 6 (50%) | Orange | Failed Input Queue RAM Test |
| 7 (70%) | Orange | Failed Output Queue RAM Test |

Note: Enabling the Diagnostic function activates tests similar to the one performed upon power on. After successfully completing diagnostics, the system returns to normal operation.

Port Status Display

| | |
|----------|---|
| Port 1 → |      |
| Port 2 → |      |
| Status → | Link TX RX Full 100 |

Link Status (Link) - Indicates a valid network connection associated with the port.

| LED Activity | Condition | Indication |
|--------------|-----------|---|
| STEADY LIGHT | ON | Indicates a valid link has been established on this port. |
| NO LIGHT | OFF | No valid link has been established on this port. |

Troubleshooting: If the Link LED does not light up when a device is connected to its corresponding port, check that both the hub and connected device are powered on. For devices connected to the hub using twisted-pair cable, check that the cable length does not exceed 100 meters. You should have standard, straight-through cables and not crossover or other specialized cables.

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Transmit (TX) - Indicates outgoing traffic traversing the port.

| LED Activity | Condition | Indication |
|----------------|-----------|---|
| BLINKING LIGHT | ON | Indicates the port is transmitting packets; blinking is proportional to the traffic passing through the port. |
| NO LIGHT | OFF | No packets are being transmitted from this port. |

Receive (RX) - Indicates incoming traffic entering the port.

| LED Activity | Condition | Indication |
|----------------|-----------|--|
| BLINKING LIGHT | ON | Indicates the port is receiving packets; blinking is proportional to the traffic passing through the port. |
| NO LIGHT | OFF | No packets are being received on this port. |

Full-Duplex (Full) - Indicates that communications have been set to full-duplex operation for the indicated port.

| LED Activity | Condition | Indication |
|--------------|-----------|--|
| STEADY LIGHT | ON | Port is set for full-duplex operation. |
| NO LIGHT | OFF | Port is set for half-duplex operation. |

Note: Full-duplex operation only applies to point-to-point access (e.g., when attaching the SwitchHub to a server or to a workstation). When connecting the SwitchHub to other compatible hubs, use a standard cascaded connection.

100BASE-TX (100) - Indicates that communications have been set to 100Mbps. (The transmission speed for any device directly attached to the SwitchHub is automatically sensed at 10Mbps or 100Mbps.)

| LED Activity | Condition | Indication |
|--------------|-----------|--|
| STEADY LIGHT | ON | Port is set for 100BASE-TX connection. |
| NO LIGHT | OFF | Port is set for 10BASE-T connection. |

Rear Panel

The unit's rear panel includes two logical Ethernet ports and a full-range power socket. Although 10BASE-T and 100BASE-TX connections are automatically sensed by the SwitchHub, you must use the Configure button to set the data transfer mode to full-duplex or half-duplex operation, as described under Setting the Communication Mode in this chapter. The following figure shows the rear panel.

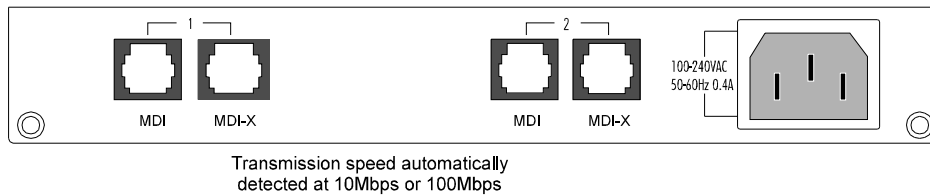


Figure 2.3 The SwitchHub-2s Rear Panel

Ethernet Ports

The SwitchHub has 2 logical RJ-45 Ethernet ports – one MDI-X port for connecting to a workstation or server and one MDI port for connecting to another network interconnection device, such as a hub or switch. When using Fast Ethernet, these ports can also be connected to devices such as a high-speed server or Ethernet backbone. Use straight-through twisted-pair cable to connect to any of the switching ports.

Note: Either the Port 1 or Port 2 MDI port can be used as a daisy-chain port to connect the switching hub to other compatible hubs using straight-through twisted-pair cable .

Power Socket

The power socket accepts AC power from 100 to 240V at 50 to 60Hz. The unit is equipped with a universal full-range power source.

Chapter 3: Setup and Configuration

This chapter provides information on pre-installation requirements, establishing network connections, and configuring the system.

Pre-Installation Requirements

Before you start making network connections to the SwitchHub, make sure you can provide the right operating environment, including power requirements, and proximity to other network devices that are to be connected. Verify the following installation requirements:

- Power requirements: 100 to 240 VAC at 50 to 60 Hz. The hub's power supply automatically detects the input voltage level.
- The SwitchHub should be located in a cool dry place, with at least 10 cm. of space at the front and back for ventilation.
- Check if network cables and connectors needed for installation are available.
- Find a suitable location at the center of the devices you want to link, and near a power outlet

Connecting the Hub System

The SwitchHub has two logical RJ-45 Ethernet ports. Use twisted pair cable to connect either of the RJ-45 ports to a server/workstation or to another compatible hub as described below.

Server/Workstation Connection

1. Prepare the workstations you wish to network. Make sure they have properly installed 10BASE-T or 100BASE-TX network interface cards.
2. Prepare straight-through twisted-pair cables with RJ-45 plugs at both ends. Connect one end of the cable to the RJ-45 port of the PC's network interface card, and the other end to one of the MDI-X station ports on the hub.

Category 5 twisted-pair cable must be used for 100Mbps connections. Although Category 3, 4 or 5 cable can be used for 10Mbps connections, we highly recommend using Category 5 cable for these connections to avoid any unnecessary expense or confusion if you subsequently upgrade to Fast Ethernet.
3. Set the communication mode via the Configure button to half-duplex or full-duplex operation to match the network interface card installed in your computer. (Refer to Setting the Communication Mode in Chapter 2.)

Notes:

1. Make sure that the length of any twisted-pair cable does not exceed 100 meters.
2. Do not plug a phone jack connector into the RJ-45 port. This may damage the hub. Instead, use only twisted-pair cables with RJ-45 connectors that conform to FCC standards.

Daisy-Chain Connection

1. Prepare Category 5 straight-through twisted-pair cables with RJ-45 plugs at both ends. Connect the SwitchHub to another compatible hub using the crossover port (labeled MDI) on either the SwitchHub or on the attached hub (but not both). Also note that as a general rule, the length of twisted-pair cable should not exceed 100 meters.
2. Set the communication mode via the Configure button to half-duplex or full-duplex operation to match the connected device. (Refer to Setting the Communication Mode in Chapter 2.)

The IEEE 802.3 standard recommends restricting the number of hubs connected in a stack via twisted-pair cable to 7; while IEEE 802.3u provides even stricter recommendations for Fast Ethernet. Therefore, when cascading devices other than the SwitchHub-2s, please refer to the accompanying documentation for restrictions on stack size. However, note that because the SwitchHub breaks up the path for connected devices into separate collision domains, you should not include the switching hub or connected cabling in your calculations for cascade length involving other devices.

Note: In contrast to repeater hubs, a cascade of switches breaks up the collision domain. The number of switches that can be cascaded is therefore theoretically unlimited. However, in practice, the length of a cascade may be limited by the time-out requirements of the particular applications running over the network.

Providing Power to the SwitchHub

1. Power on the hub by plugging the power cord into the power socket at the rear of the SwitchHub, and the other end into a power outlet.
2. Check the LED marked Power on the front panel to see if it is on. The unit will automatically select the setting that matches the connected input voltage. Therefore, no additional adjustments are necessary when connecting it to any input voltage within the range marked on the rear panel.
3. The SwitchHub performs a self-diagnostic test upon power on. (Note that this test takes about 50 seconds to complete.) For details about the system self-diagnostic test, refer to the following section.

Diagnostic Tests

Upon Power On

Upon power on, the system performs an internal self-diagnostic test of major hub components. If any component fails during the test, the hub will try to complete the diagnostic procedure. Otherwise, the system will hang. For related information, refer to Diagnostics Display Mode in Chapter 2.

The components to be tested include:

- System ROM
- System EEPROM
- Ports 1 - 2

During Normal Operation

You can use the Configure button any time you want to perform a diagnostic test. When testing begins, the system leaves normal operation. If no problem is encountered by the diagnostic test, the system automatically returns to normal operation.

Setting the Display Mode

The Configure button is located on the left front panel. This button is used to access the following configuration functions in sequence:

- **Bandwidth Utilization** The percentage of LAN bandwidth utilized.
- **Forwarding Ratio** The percentage of packets that are forwarded to the other port.
- **Filtering Ratio** The percentage of packets filtered because the destination is in the current segment.
- **Collision Ratio** The percentage of collisions occurring out the total packets transmitted by the port.
- **Full/Half Duplex** Sets port communication mode to full-duplex or half-duplex operation.
- **Diagnostics** Tests the status of various system components.

A “*long press*” on the Configure button is used to initiate basic configuration. (LED indicators light up to indicate which configuration function the system is in.) A “*short press*” switches from one function to the next. And another “*long press*” implements the current selection.



"Long press" in this user's guide means pressing the Configure button for more than 2 seconds and then releasing it. "Short press" means pressing the Configure button and immediately releasing it. Also, note that if this button is not pressed within 10 seconds, the system will return to normal operation.

Selections Available

This section shows the information available for each display mode and the corresponding LED indicators. The display functions are listed here in the sequence selected by the configure button. For a more detailed description of these indicators, refer to Chapter 2.

Bandwidth Utilization

Active LED: Util% (ON)

In this mode, the statistical indicators show the percentage of valid data handled by each port on the hub compared to available bandwidth.

Packet Forwarding Ratio

Active LED: Forward% (ON)

In this mode, the statistical indicators show the percentage of packets that must be forwarded by bridging hardware to the other port on the switching hub.

Packet Filtering Ratio

Active LED: Filter% (ON)

In this mode, the statistical indicators show the percentage of packets that must be filtered from the switching hub by bridging hardware because the destination address is on the segment connected to the receiving port (i.e., in the same segment with the source address).

Collision Ratio

Active LED: Coll% (ON)

In this mode, the statistical indicators show the percentage of packet collisions occurring out of the total packets transmitted by the respective port.

Full/Half Duplex Mode Selection

Active LED: Full/Half (ON)

This function is used to set the communication mode for selected ports to full-duplex or half-duplex.

1. Use the Configure button to light the Full/Half Display Mode indicator. Note that before the Configure button is released, the current communication mode selections will be displayed by the Port Status Full LEDs (i.e., if full-duplex mode has been previously set for a port, the corresponding Full LED will be lit). After the Configure button is released, the Full LED for Port 1 will begin to flash.
2. To change the current setting for a port, use a "short press" (i.e., light the Full LED to select full-duplex communications, or extinguish the Full LED to select half-duplex communications), and then use a long press to effect the setting and move on to Port 2.
3. When finished, use a long press to terminate duplex mode selection.

Diagnostic Function

Active LED: Diag (ON)

Enabling the diagnostic function will activate tests similar to the one performed upon power on. For details on these tests, refer to Diagnostics Tests earlier in this chapter. After successfully completing diagnostics, the system returns to normal operation.

Verifying Port Status

Check each connection by viewing the port status indicators listed below. (For a more detailed description of these indicators, refer to Chapter 2.)

- **Link** Indicates that the port has established valid network connection.
- **Transmit** Indicates outgoing traffic traversing the port.
- **Receive** Indicates incoming traffic entering the port.
- **Full** Indicates that communications have been set to full-duplex.
- **100** Indicates that communications have been set to 100Mbps.

If the Link status indicator is not functioning properly, or you experience any other difficulties in setting up the hub, refer to Appendix A.

Verifying System Operation

Verify that all attached devices have a valid connection. The hub monitors link status for each port. If any device is properly connected to the hub and transmitting a link beat signal, the Link indicator lights up for the corresponding port. If the Link indicator fails to light up when you connect a device to the hub, check the following items -

- Be sure the twisted-pair cable is properly attached to the connected device and the hub. Verify that the RJ-45 plug snaps into place when attached.
- See if the twisted-pair cable is functioning properly by using it for another port and attached device that displays valid indications when connected to the network.
- Check the length of the twisted-pair cable to be sure it does not exceed 100 meters.

SwitchHub-2s User's Guide

- Verify that the workstation's adapter card is functioning properly by trying it in another computer that has been successfully connected to the network.

If you still can't resolve the problem, please refer to Troubleshooting in Appendix A.

Appendix A: Troubleshooting

Diagnosing Hub Indicators

The SwitchHub-2s can be easily monitored through its comprehensive panel indicators. These indicators assist the network manager in identifying problems the hub may encounter. This section describes common problems you may encounter and possible solutions.

Symptom: Link indicator does not light up (green LED) after making a connection.

Cause: Workstation's network adapter, cable or hub port is defective.

Solution: The most common cause for a bad connection to a workstation or server is a defective network adapter or cable connection. Check the workstation's network adapter and cable connections for possible defects. Replace the defective adapter or cable.

Symptom: Power indicator does not light up (green LED) after power on.

Cause: Defective power supply or CPU

Solution: Have your unit's power supply or CPU replaced. Ask for dealer assistance.

Use the diagnostic procedures described in Chapters 2 and 3 to verify that all other system components are functioning properly. If any component fails the diagnostic test, contact your Accton distributor for assistance.

System Diagnostics

Installation

Verify that all system components have been properly installed. If one or more components appear to be malfunctioning, test them in an alternate environment where you are sure that all the other components are functioning properly.

Transmission Mode

Be sure each port on the SwitchHub is set to the same transmission mode as the attached device; i.e., full-duplex or half-duplex. (Refer to Setting the Communication Mode in Chapter 2 for a detailed description.)

Cabling

1. Verify that the cabling type is correct. Be sure all cable connectors are securely seated in the required ports. Straight-through cable should be used for all standard twisted-pair connections.
2. Make sure all devices are connected to the network. Equipment may have been unintentionally disconnected from the network.

External Adapters

Make sure the network adapter cards installed in the workstations are in good working condition.

Configuration

If problems occur after altering the network configuration, restore the original connections, and try to track the problem down by implementing the new changes, one step at a time. Ensure that cable distances and other physical aspects of the installation do not exceed recommendations.

Hub Integrity

As a last resort verify the hub's integrity with a power-on reset. Turn the power to the hub off and then on. If the problem still persists and you have completed all the preceding diagnoses, then contact your Accton distributor for further assistance. (Refer to Appendix E.)

Appendix B: Port and Cable Assignments

RJ-45 Port

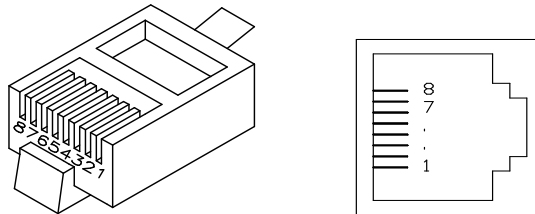


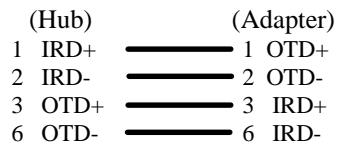
Figure B-1 RJ-45 Connector (on the Hub Side)

| Pin | MDI-X Assignment Station Port 1 ~ 2 | MDI Assignment Cascade Port 1 ~ 2 |
|---------|--|--------------------------------------|
| 1 | Input Receive Data + | Output Transmit Data + |
| 2 | Input Receive Data - | Output Transmit Data - |
| 3 | Output Transmit Data + | Input Receive Data + |
| 6 | Output Transmit Data - | Input Receive Data - |
| 4,5,7,8 | Not Used | Not Used |

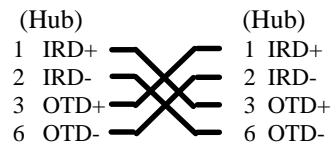
Table B-1 RJ-45 Pin Assignments

Schematics for both straight and crossover twisted-pair cable are shown below.

Straight-Through



Crossover



Appendix C: Specifications

Product Specifications

Basic Criteria

| | |
|-----------------------|--|
| Access Method | CSMA/CD, 10/100 Mbps (auto-sensed) |
| Standards Conformance | IEEE 802.3 10BASE-T, IEEE 802.3u 100BASE-TX |
| Communication Mode | Full-duplex or half-duplex |
| Media Supported | <i>10BASE-T</i> Category 3,4,5 twisted-pair cable <i>100BASE-TX</i> Category 5 twisted-pair cable |
| Number of Ports | 2 RJ-45 ports (selectable 10BASE-T or 100BASE-TX per port) |
| Dimensions | 273mm x 166mm x 42.9mm (10.75" x 6.54" x 1.69") |
| Power Requirements | Full range power input, 100 to 240V, 50/60 Hz, 27 watts max. |
| Temperature | 0°C to 50°C (Standard Operating) |
| Humidity | 5% to 95% (Noncondensing) |
| Certification | CE Mark |
| Emissions | FCC Class B, VCCI Class 2, CISPR Class B |
| Immunity | IEC 801-2,3,4, EN60555-2 Class B, EN60555-3 |
| Safety | UL, CSA, TÜV/GS |

Switching Criteria

| | |
|---------------------------|------------------------------------|
| Network Bridging Function | filtering, forwarding and learning |
| Maximum Filtering Rate | at line speed |
| Maximum Forwarding Rate | at line speed |
| Network Latency | less than 20 microseconds |
| Address Table | 4K entries/port |
| Queue Buffer | 160K bytes/port |

Appendix D: Regulatory Standards Compliance

EMI Warning

FCC Class B Certification

Accton Technology Corporation

Model Numbers: *EH3001-TX*

FCC ID: *HED3001EHLCT-TX*

This device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Warning! This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from the one which the receiver is connected to
- Consult the dealer or an experienced radio/TV technician for help

You are cautioned that changes or modifications not expressly approved by the party responsible for compliance could void your authority to operate the equipment.

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- Warnings**
1. Wear an anti-static wrist strap or take other suitable measures to prevent electrostatic discharge whenever handling this equipment.
 2. When connecting this hub to a power outlet, connect the field ground lead on the tri-pole power plug to a valid earth ground line to prevent electrical hazards.

You may find the following booklet prepared by the Federal Communications Commission helpful:

The Interference Handbook

This booklet is available from the U.S. Government Printing Office. Washington, D.C. 20402. Stock No. 004-000-00345-4.

Note: In order to maintain compliance with the limits of a Class B digital device, Accton requires that you use a quality interface cable when connecting to this device. Changes or modifications not expressly approved by Accton could void the user's authority to operate this equipment. Suggested cable type is:

- Twisted-pair for RJ-45 connections: 10BASE-T or 100BASE-TX

You may use unshielded twisted-pair (UTP) for RJ-45 connections.

Voluntary Control Council for Interference (VCCI-2)

電波障害自主規制について

この装置は、第二種情報装置（住宅地域又はその隣接した地域において使用されるべき情報装置）で住宅地域での電波障害防止を目的とした情報処理装置等電波障害自主規制協議会(VCCI)基準に適合しております。

しかし、本装置をラジオ、テレビジョン受信機に近接してご使用になると、受信障害の原因となることがあります。

取扱説明書に従って正しい取り扱いをして下さい。

This product also complies with CISPR22 Class B (EN55022 Class B).

EN55022 Declaration of Conformance

This is to certify that the Accton Ethernet Hub is shielded against the generation of radio interference in accordance with the application of Council Directive 89/336/EEC, Article 4a. Conformity is declared by the application of EN55022:1987 Class B (CISPR 22:1985/BS 6527:1988).

CE Mark Declaration of Conformance

This is to certify that this product complies with ISO/IEC Guide 22 and EN45014. It conforms to the following specifications:

| | | |
|------|----------------------------------|-----------------------|
| EMC: | EN55022(1988)/CISPR-22(1985) | class B |
| | EN60555-2(1987) | class A |
| | EN60555-3 | |
| | prEN55024-2(1990)/IEC801-2(1991) | 4kV CD, 8kV AD |
| | prEN55024-3(1991)/IEC801-3(1984) | 3V/m |
| | prEN55024-4(1992)/IEC801-4(1988) | 1kV - (power line) |
| | | 0.5kV - (signal line) |
| | prEN50082-1(1994)/IEC801-6 | 3Vrms |

This product complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC.

Do not plug a phone jack connector into any of the RJ-45 ports.

This may damage the hub.

Les raccordeurs ne sont pas utilisé pour le système téléphonique!

Safety Compliance

Underwriters Laboratories Compliance Statement

Important! Before making connections, make sure you have the correct Cord Set. Check it (read the label on the cable) against the following specification list.

| Operating Voltage | Cord Set Specifications |
|-------------------------------|--|
| 120 Volts | UL Listed/CSA Certified Cord Set |
| | Minimum 18 AWG |
| | Type SVT or SJT three conductor cord |
| | Maximum length of 15 feet |
| | Parallel blade, grounding type attachment plug rated 15A, 125V |
| 240 Volts (For North America) | UL Listed/CSA Certified Cord Set |
| | Minimum 18 AWG |
| | Type SVT or SJT three conductor cord |
| | Maximum length of 15 feet |
| | Tandem blade, grounding type attachment plug rated 15A, 125V |
| 240 Volts (For Europe only) | Cord Set with H05VV-F cord having three conductors with minimum diameter of 0.75 mm ² |
| | IEC-320 receptacle |
| | Male plug rated 6A, 250V |

The unit automatically matches the the connected input voltage. Therefore, no additional adjustments are necessary when connecting it to any input voltage within the range marked on the rear panel.

Sicherheitshinweise

1. Die Steckdose muß sich in der Nähe des Gerätes befinden und leicht zugänglich sein.
2. Zum Reinigen den Stecker aus der Steckdose ziehen. Beim Reinigen keine Flüssigreiniger oder Sprays verwenden, sondern ein angefeuchtetes Tuch.
3. Das produkt gerät nicht in Naßräume oder in der Nähe von Wasser benutzen, wie z.B. Badezimmer, Schwimmbad, Spülbecken usw. . Das Eindringen von Wasser kann zur Zerstörung des Gerätes führen.
4. Das produkt gerät nicht auf einer instabilen Unterlage, wie z.B. Rollwagen, Gestell usw., aufstellen. Es könnte herunterfallen und Verletzungen oder Beschädigungen von Mensch und Gerät verursachen.
5. Die Belüftungsöffnungen nicht blockieren oder auf falscher Oberfläche, wie Bett, Sofa usw., stellen. Durch die Blockierung kann es zur Zerstörung des Gerätes durch Überhitzung kommen.
6. Versuchen Sie niemals dieses Gerät selbst zu warten, da beim Öffnen oder Abnehmen des Gehäuses die Gefahr eines elektrischen Schlages besteht.
7. Keine Gegenstände auf das Anschlußkabel stellen, damit es nicht durch scharfe Kanten zerstört werden kann.
8. Keinerlei Gegenstände durch die Öffnungen in das Gerät stecken, da es dadurch sonst zu Kurzschlüssen kommen kann.
9. Bei Störungen des Gerätes den Wartungsdienst verständigen.
10. Bei Reparaturen dürfen nur Originalersatzteile oder Bauteile mit gleichen Eigenschaften verwendet werden. Andere Bauteile können Feuer, elektrischen Schlag oder andere Gefahren verursachen.
11. Nach Beendigung von Wartungsarbeiten oder Reparaturen durch den Kundendienst sollte die Sicherheitsprüfung durchgeführt werden.
12. Bei längerem Stillstand des Gerätes, ist diese von der Versorgungsspannung zu trennen. Dies verhindert eine Beschädigung des Gerätes durch eine Überspannung in der Zuleitung.
13. Der arbeitsplatzbezogene Lärmschutzpegel nach DIN 45 635 ist kleiner 70dB (A).

Appendix E:

Product Support Services

Product Registration

Fill in the Owner Registration Card and mail it to Accton Technology Corporation. Accton will keep your record and inform you of any new Accton unit developments.

Problem Report

If problems occur during unit operation, please check the adapter configuration settings, cables, connectors, network terminators, hardware compatibility and other network components.

Write a description of the problem, including what problems occurred, when they occurred, duration of the problems, the unit number, serial number, hardware, software and the DOS version that you are using. Then contact your dealer or Accton Technology Corporation for assistance.

Hardware Repair Service

You must get an RMA (Return Materials Authorization) number before returning any hardware for repair. To obtain this number please inform Accton of your company name, address, unit name and model number, contact person, telephone number, and a problem description list. If your unit is under repair warranty you must also give your purchase date. Carefully pack your hardware. If possible, use the original carton. Mark the RMA number on the carton and send it to your dealer.

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After repair, Accton will inform you of the date of delivery and the exact amount due. Please send the payment by T/T (Telegram Transfer), and Accton will send you the fixed component after receiving payment. With or without warranty, if the hardware is found to be free of defects, you will only be charged for testing and handling.

Software Update and Upgrade Service

Accton constantly improves its software units by adding enhancements and new features. Minor software updates are free of charge. If greater changes have been made to the software, Accton offers software upgrade services at a specially reduced price.

Bulletin Board Service (BBS)

- In countries other than the U.S., call 886-35-770-654 to reach Accton Taiwan's modem line. Modems with 14400 through 2400 baud are supported. Choose 8 data bits, 1 stop bit and no parity. Standard VT100 terminal emulation is supported.
- In the United States, call 408-452-8828 to reach the Accton USA's BBS line. Modems with 14400 through 2400 baud are supported. Choose 8 data bits, 1 stop bit and none parity. Standard VT100 terminal emulation is supported.

Interactive Fast Fax (U.S.A. office)

Printed technical documentation can be FAX'ed to your FAX machine, 24-hours a day.

- Call 408-452-8811 to reach Accton's interactive Fast FAX service. You will need a Touch-Tone phone and a FAX machine (or equivalent). Choose document 911 for a listing of technical bulletins.

Technical Support

Your dealer or installer is the person who understands your network and Accton units. If neither is available to help you, Accton technical support engineers are available by FAX, mail or phone.

- Send your technical questions by FAX to:
International Headquarters: 886-35-770-267
USA Headquarters: 408-452-8988
- To obtain software upgrades connect via ftp to ftp.accton.com.tw
- Send your technical questions by email to support@accton.com.tw
- Mail your technical questions to:

| | |
|--|--|
| International Headquarters Accton Technology Corporation Attn: Technical Support No. 1 Creation Road III Science-based Industrial Park Hsinchu 300, Taiwan, R.O.C. | USA Headquarters Accton Technology Corporation Attn: Technical Support 1962 Zanker Road, San Jose, CA 95112, U.S.A. |
|--|--|

During local business hours, call:

| | |
|--|---|
| International Headquarters (Monday through Friday, 8 am to 6 p.m.): 886-35-770-270 | USA Headquarters (Monday through Friday, 7 am to 5 p.m. Pacific Time): 408-452-8900 or 800-926-9288 |
|--|---|

Limited Warranty

Accton warrants to the original owner that the product delivered in this package will be free from defects in material and workmanship for the lifetime of the product. For the warranty to apply, you must register your purchase by returning the registration card indicating the date of purchase and including proof of purchase. There will be a minimal charge to replace consumable components, such as fuses, power transformers, and mechanical cooling devices. The warranty does not cover the product if it is damaged in the process of being installed. Accton recommends that you have the company from whom you purchased this product install it.

THE ABOVE WARRANTY IS IN LIEU OF ANY OTHER WARRANTY, WHETHER EXPRESS, IMPLIED OR STATUTORY, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR ANY WARRANTY ARISING OUT OF ANY PROPOSAL, SPECIFICATION OR SAMPLE. ACCTON SHALL NOT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES. ACCTON NEITHER ASSUMES NOR AUTHORIZES ANY PERSON TO ASSUME FOR IT ANY OTHER LIABILITY.

Customer Remedies

If the product is found to be defective within the first two years from the later of date of purchase or date of manufacture, Accton's entire liability and your exclusive remedy for any breach of warranty, shall be, at its option, to repair or replace the product at no charge except as set forth below. If the product is found to be defective after two years from the later of date of purchase or date of manufacture, Accton will charge a process and handling fee, provided that you deliver the product along with a return material authorization (RMA) number either to the company from whom you purchased it or to Accton. Accton warrants the repaired or replaced product to be free from defects in material and workmanship for the remainder of the original product's warranty period. Consumable components are warranted only for two years.

Return Process

Before you may return any Accton product to Accton, you must request an RMA number by calling, FAXing or writing Accton's Service Department at the address listed below. If you ship the product, you must assume the risk of damage or loss in transit. You must use the original container (or the equivalent) and pay the shipping charge. Accton may replace or repair the product with either a new or reconditioned product, and the returned product becomes Accton's property. At Accton's sole discretion, Accton will issue a credit for either a comparable replacement Accton product or credit the original purchase price towards the purchase of any Accton product for any unrepairable, defective product.

This warranty does not cover replacement of products damaged by abuse, accident, misuse, neglect, alteration, repair, disaster, improper installation or improper testing.

ACCTON SHALL NOT BE HELD LIABLE FOR ANY LOSS OF PROFITS, LOSS OF USE, INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES CAUSED BY THE USE OF THIS PRODUCT OR INABILITY TO USE IT, EVEN IF THE COMPANY OR ACCTON HAS BEEN ADVISED OF SUCH LIABILITY OR OTHER SPECIAL CLAIMS.

If you purchased this product in the USA, be aware that some states do not allow limitations on how long an implied warranty lasts, so the above limitations may not apply to you. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may have other rights which vary from state to state. All parts or components contained in this product are covered by Accton's Limited Lifetime Warranty for this product. The product may contain fully tested, recycled parts, warranted as if new.

For warranty information:

All territories except North and South America:

Accton Technology Corporation, International Headquarters
No. 1, Creation Rd. III, Science-based Industrial Park, Hsinchu 300, Taiwan, R.O.C.
Phone: 886-35-770-270 Fax: 886-35-770-267 BBS: 886-35-770-654

North and South America:

Accton Technology Corporation, USA Headquarters
1962 Zanker Road, San Jose, CA 95112, U.S.A.
Phone: 408-452-8900 Fax: 408-452-8988 BBS: 408-452-8828

Accton Distributors

Accton Technology Corporation

International Headquarters,
No. 1 Creation Rd. III,
Science-based Industrial Park,
Hsinchu 300, Taiwan, R.O.C.
Hsinchu: Phone: 886-35-770-270,
Fax: 886-35-770-267, 886-35-775-541
BBS: 886-35-770-654
Taipei: Phone: 886-2-577-1220 to 9
Fax: 886-2-577-0816

Accton USA,
1962 Zanker Road,
San Jose, CA 95112, USA
Phone: 408-452-8900, 408-452-8080
Fax: 408-452-8988
BBS: 408-452-8828
FAST FAX: 408-452-8811

Accton UK,
The Mill Horton Road,
Stanwell Moor,
Staines. Middx. TW19 6BJ United Kingdom
Phone: 44-1753-687677, 44-1753-680109
Fax: 44-1753-689010

Accton Australia,
Unit 23, No.27 Doomben Ave.,
Eastwood, N.S.W. 2122, Australia
Phone: 612-8582436
Fax: 612-8581723

Accton Deutschland,
Bahnhofstr. 6,
65623 Hahnstätten, Germany
Phone: 49-64-30-22-17
Fax: 49-64-30-22-70

Accton Japan,
Kano Bldg. 7F,
1-25-1 Nishi-Gotanda,
Shinagawa-ku,
141 Tokyo, Japan
Phone: 81-3-3495-1351
Fax: 81-3-3495-1352

Ordering Information

- **SwitchHub-2s** (EH3001-TX) 2-port Fast Ethernet Switch

Glossary

10BASE-T

IEEE's specifications for 10 Mbps Ethernet using twisted-pair cable (100 Ω STP or UTP). The maximum length of cable for a point-to-point connection is 100 meters.

100BASE-TX

IEEE's specifications for 100 Mbps Ethernet using twisted-pair cable (100 Ω STP or UTP). The maximum length of cable for a point-to-point connection is 100 meters.

Bus Topology

A network topological arrangement where only one path exists between any two nodes and data transmitted by any node is concurrently available to all other nodes on the same transmission medium.

Configuration

The way to set up a computer, server, or local area network.

Connection

A logical binding between two or more users of an interconnection service.

Daisy-Chain Port

MDI port on the SwitchHub-2s. Port 1 or 2 can be used to connect the fast Ethernet switch to other compatible hubs in a daisy-chain configuration.

Ethernet

A network communication system developed and standardized by DEC, Intel, and Xerox, using baseband transmission, CSMA/CD access, logical bus topology, and coaxial cable. The successor IEEE 802.3 standard provides for integration into the OSI model and extends the physical layer and media with repeaters and implementations that operate on fiber optics, broadband, and twisted-pair.

IEEE 802.3 Standard

Standard for the physical and electrical connections in local area networks developed by the IEEE. The IEEE 802.3u standard covers these same issues for 100 Mbps networks.

LED

Light emitting diode on the front panel of the SwitchHub used for monitoring a hub or network condition. An LED display corresponds to a hub condition.

Local Area Network (LAN)

A group of interconnected computers and support devices.

RJ-45 Connector

Most common terminator for twisted-pair wiring.

Shielded Twisted-Pair (STP)

Twisted-pair wire covered with an external aluminum-foil or woven-copper shield designed to reduce excessive noise pick up or radiation.

Station Port

SwitchHub-2s MDI-X ports which are used for connecting the hub to any workstation or server that has a properly installed network adapter card.

Unshielded Twisted-Pair (UTP)

Cable composed of two insulated wires twisted together to reduce electrical interference; used in common telephone cord.

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